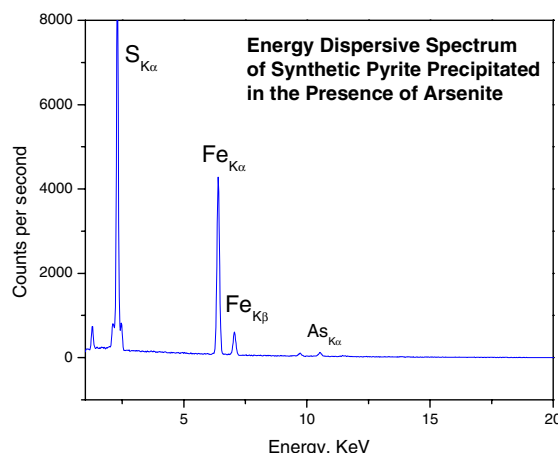


*Synthetic pyrite grains containing arsenic  
(SEM micrograph)*



**Project Title:** “Natural Attenuation of Metals During Iron Sulfide Formation”

**Investigators:** Richard Wilkin (U.S. EPA, Office of Research and Development, National Risk Management Research Laboratory, GWERD, Ada, OK 74820; 580-436-8874)

**Collaborators:** U.S. Geological Survey, Western Ecological Research Center; Trent University

**Background and Objectives:** Analyses of sediments have indicated a close association between the concentrations of iron sulfides and trace metals, yet there are few systematic investigations that explore the factors controlling trace element abundance in FeS and FeS<sub>2</sub>, or conceptual models that describe impurity incorporation mechanisms. Three general processes have been proposed as important for controlling metal concentrations in reducing environments: 1) precipitation of pure metal (Me) sulfides; 2) formation of Me-Fe sulfide solid solutions by isomorphous substitution; and, 3) adsorption of trace metals onto the surfaces of iron sulfide particles. Many elements of environmental interest are found closely associated with iron sulfides including V, Cr, Mn, U, Co, Ni, Mo, Cu, Zn, As, Se, Ag, Cd, Sb, Hg, Tl, Pb, and Bi. The concentrations of these metals and metalloids within pyrite, for example, can be quite variable. In the case of As, pyrites with As contents approaching 8 to 10 wt% have been documented. Evidence for the pyrite-metal relationship is based mainly on indirect sequential extraction methodologies and direct microprobe measurements of relatively large pyrite grains. Questions remain concerning the influence of depositional environment on the processes of trace metal incorporation into iron sulfide phases, especially with respect to the relationship between mineral formation kinetics and metal uptake. This study evaluates the effects of nucleation rate and growth rate of pyrite on the uptake of metals, and specifically attempt to identify environments where trace metal incorporation into pyrite is optimized.

**Approach:** The research approach involves laboratory experimentation and detailed analysis using a variety of wet-chemical and solid-phase characterization techniques.

**Accomplishments:**

- Wilkin, R.T. and Ford, R.G. (2002). Use of hydrochloric acid for determining solid-phase arsenic partitioning in sulfidic sediments. *Environmental Science and Technology*, v. 36, p. 4921-4927.
- Wilkin, R.T., Wallschläger, D., and Ford, R.G. (2003). Speciation of arsenic in sulfidic waters. *Geochemical Transactions*, v. 4. 1-7.
- Smieja, J. and Wilkin, R.T. (2003). Preservation of As(III) in sulfidic waters. *Journal of Environmental Monitoring*, accepted.
- Wilkin, R.T. (2003). Metal sulfides in sediments. In *Encyclopedia of Sediments and Sedimentary Rocks*, ed. G. Middleton, Kluwer, in press.